

BEST AVAILABLE COPY

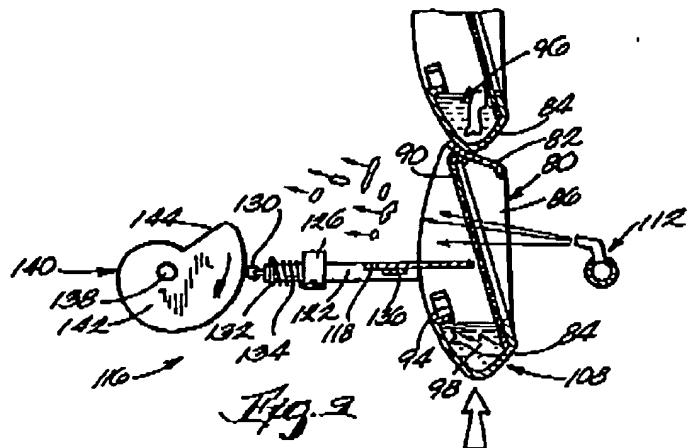
(12) UK Patent Application (19) GB (11) 2 254 572 (13) A

(43) Date of A publication 14.10.1992

(21) Application No 9122501.3	(51) INT CL ⁴ B01D 33/76 33/04 33/50
(22) Date of filing 24.10.1991	
(30) Priority data (31) 683327 (32) 10.04.1991 (33) US	(52) UK CL (Edition K) B1D DMFX U1S S1270 S1290 S1407 S1903
	(56) Documents cited None
(71) Applicant Envirex Inc (Incorporated in the USA - Delaware) 1901 South Prairie Avenue, Waukesha, Wisconsin 53186, United States of America	(58) Field of search UK CL (Edition K) B1D DMFA DMFX DMLB DMLC DPLD INT CL ⁵ B01D Online WP1
(72) Inventors Thomas J Casper Gary L Dombrowski	
(74) Agent and/or Address for Service Mathiesen Macara & Co The Coach House, 6-8 Swakeleys Road, Ickenham, Uxbridge, Middlesex, UB10 8BZ, United Kingdom	

(54) Shield apparatus for travelling water screen

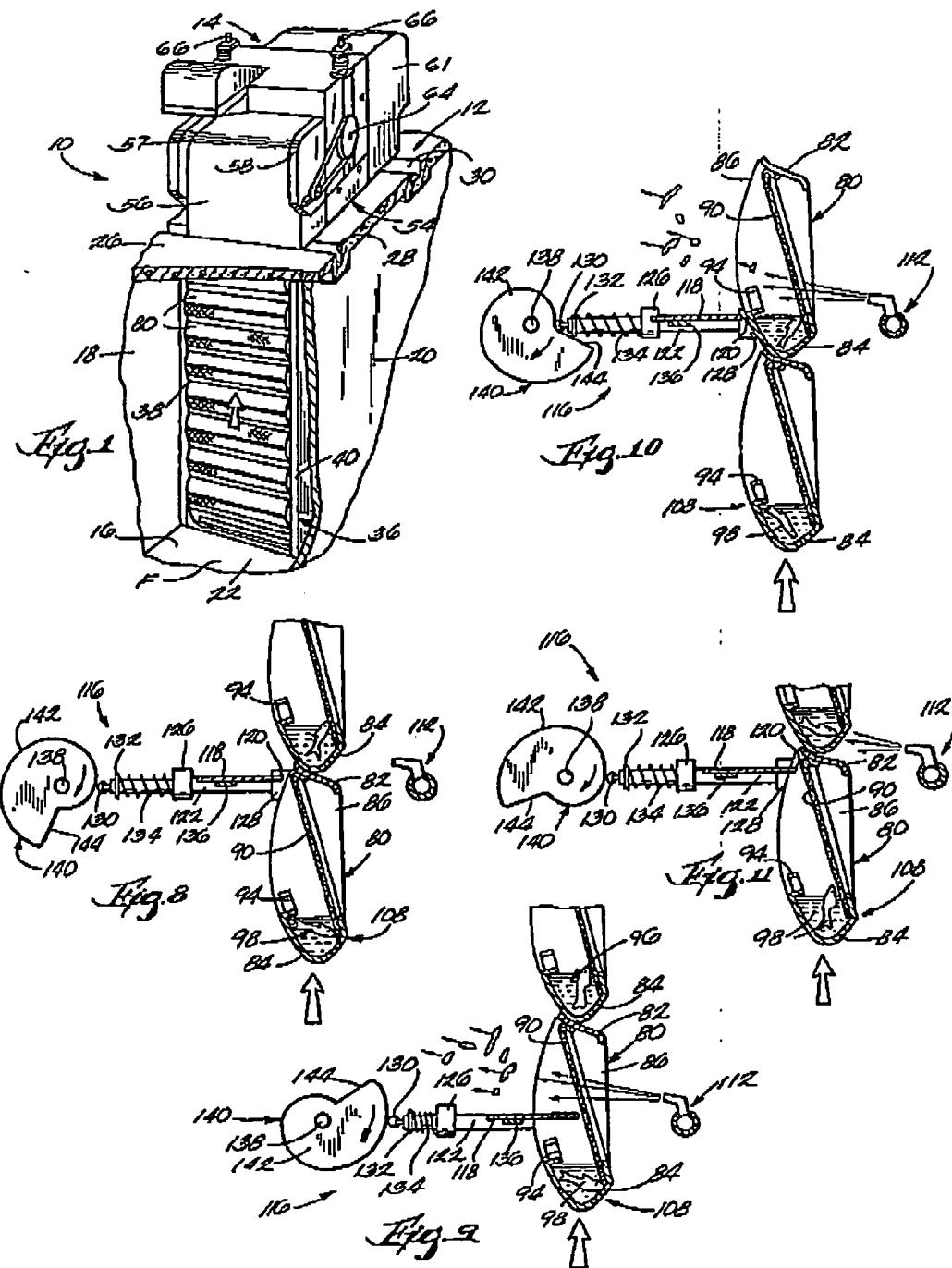
(57) A travelling water screen for filtering debris and aquatic life from water flowing through a sluice comprises an endless chain of screen units 80 each having a screen panel 90 and a lower bucket 84 which collects any fish 98. On the upstream rising run of the chain, the successive panels 90 are cleared of debris by high pressure spray nozzles 112, while a reciprocating shield 118 moves in sequence with the units 80 to prevent the debris from falling into buckets 84 and injuring the fish. The fish remain in buckets 84, to be flushed therefrom by low pressure sprays at the top of the descending run of the chain and returned safely to the water source.



This print incorporates corrections made under Section 117(1) of the Patents Act 1977.

GB 2 254 572 A

1/4



2/4

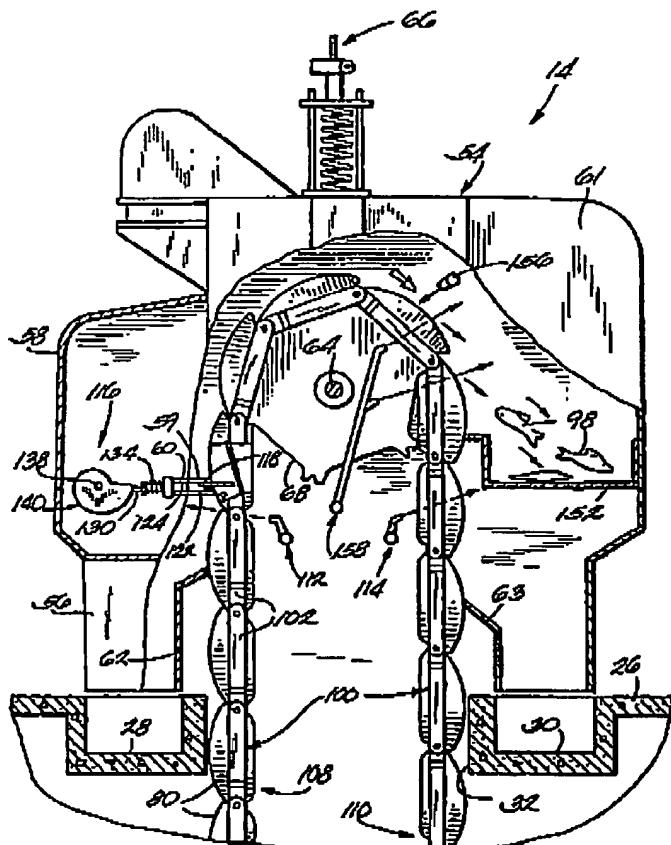


Fig. 3

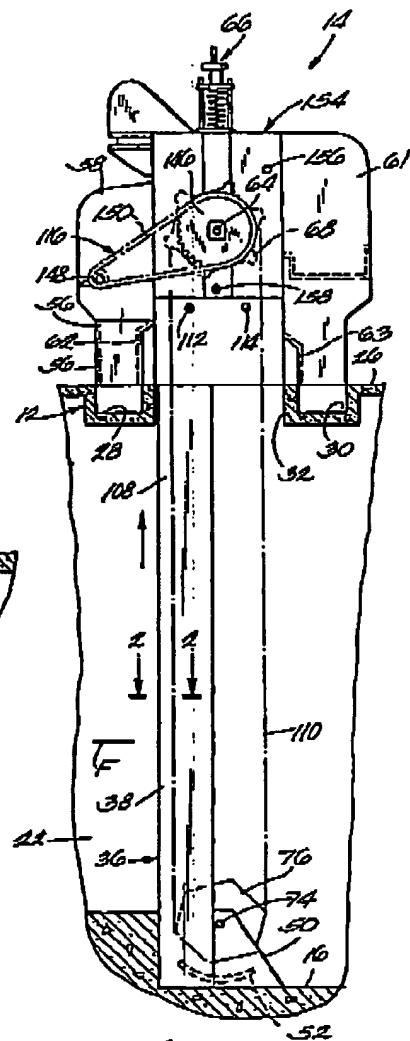


Fig. 2

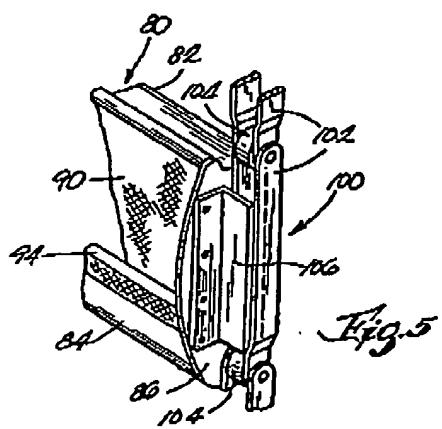


Fig. 5

3/4

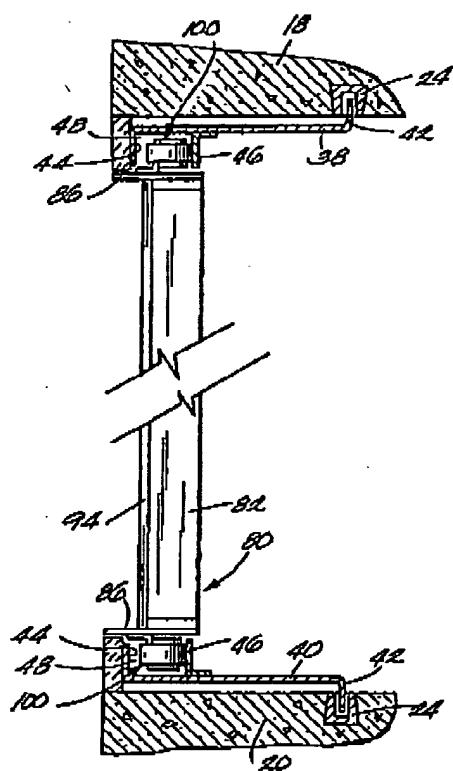


Fig. 4

4 / 4

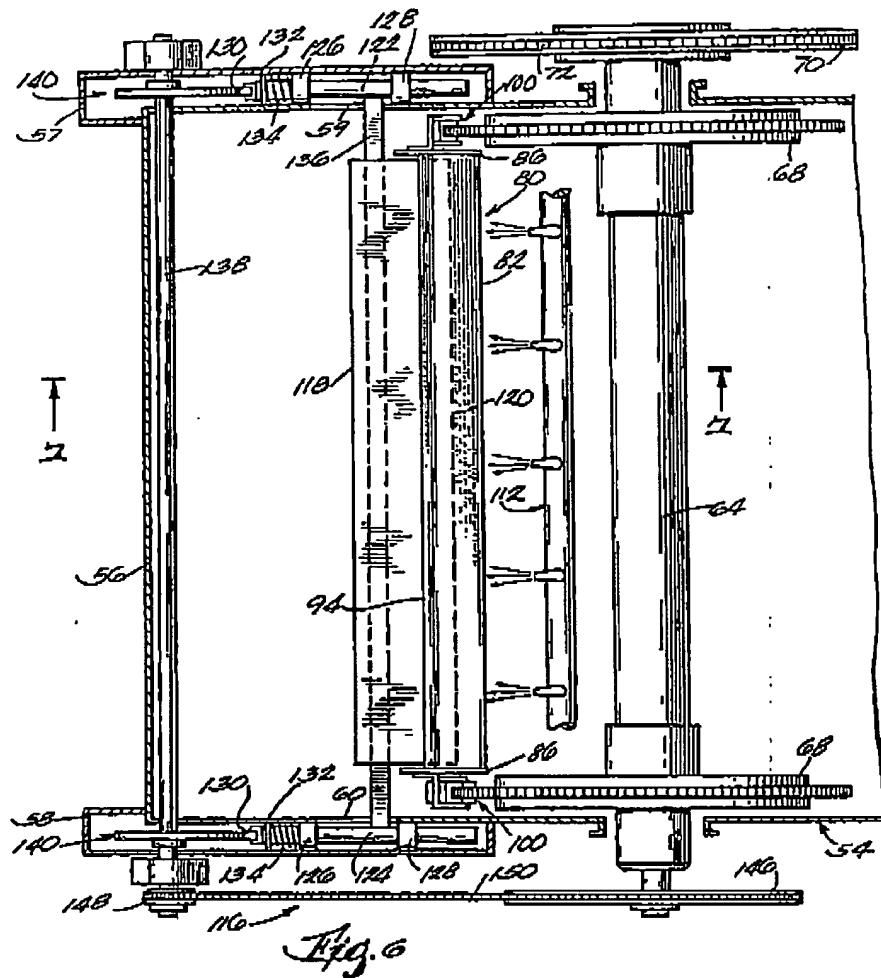


Fig. 6

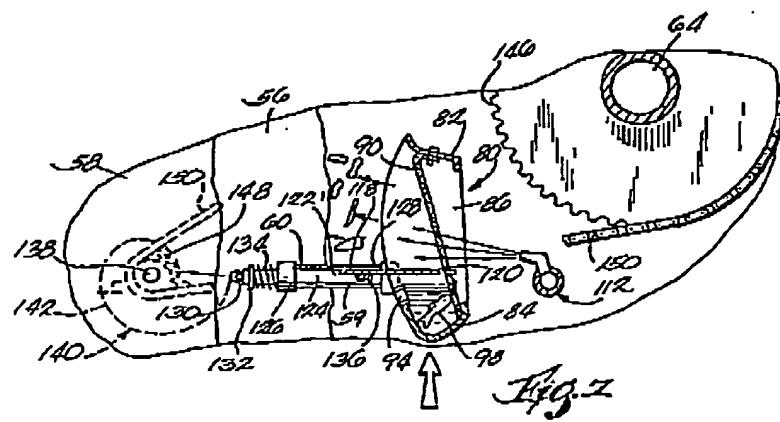


Fig. 7

2254572

- 1 -

SHIELD APPARATUS FOR TRAVELING WATER SCREEN

The present invention relates generally to traveling water screens, and more particularly to a shield apparatus for protecting aquatic life from injury as it is carried by the water screens.

Traveling water screens are used in applications where it is necessary to screen or filter debris and fish from large volumetric flows of water. A typical application is a power plant which requires a continuous, large volume stream of cooling water. Normally, the water for this purpose is supplied via a watercourse extending between the plant and a water source such as a lake, river, or ocean. Debris and fish enter the watercourse with the water and must be filtered or screened out to prevent disruption of the operation of the plant or damage to equipment.

A number of traveling water screens are typically positioned in a concrete structure spanning the watercourse. Each traveling water screen generally includes a series of screening panels attached between a pair of chains which are in turn supported on a pair of head sprockets at the top, and a pair of foot sprockets at the bottom, so that the screening panels form an endless band. The head sprockets are driven so that the screening panels lift out of the water on the upstream side, taking fish and impinging debris with them. Debris is then removed by a high-pressure water spray and deposited in a collection trough. Fish are subsequently removed by a low-pressure water spray and returned to the water source at a remote location. The screen units then descend on the downstream side and pass around the foot sprockets and ascend again on the upstream side.

- 2 -

According to the invention there is provided a traveling water screen for filtering debris and aquatic life from water flowing through a sluice, said traveling water screen comprising

a frame,

an endless screen member supported on said frame for travel through the water, and adapted to carry debris and aquatic life,

means adjacent said endless screen member for removing debris deposited thereon, and

means for shielding aquatic life carried by said endless screen member from debris removed therefrom.

Preferably the endless screen member comprises a series of screen units each including a screening panel upon which debris impinges, and a bucket adapted to receive aquatic life. The debris removing means usually includes a spray apparatus equipped with nozzles for spray cleaning each successive screening panel as it travels past the nozzles, and the shielding means preferably comprises a shield member which is successively positioned above each bucket as the screening panel associated therewith is cleaned. The shield member functions to significantly reduce or prevent falling debris from injuring aquatic life in the buckets.

The invention thus provides for the protection of aquatic life carried by the screen units of a traveling water screen from injury, and in particular from injury caused by falling debris which is dislodged from the screen units during the debris removal or screen cleaning operation.

- 3 -

Also according to the invention there is provided a shield apparatus for use with a traveling water screen including an endless screen member having an upward run, the endless screen member including a series of screen units each including a bucket which opens in the direction of travel of the endless screen member to receive aquatic life, and a screening panel associated with the bucket and extending therefrom in the direction of travel of the endless screen member, and an apparatus for removing debris from successive screening panels, said shield apparatus comprising,

a shield member on the upstream side of the upward run, and

means for successively positioning said shield member above each bucket as the screening panel associated therewith is acted upon by the apparatus for removing debris.

In its preferred form the shield apparatus is simple, durable, and economical, and can be used on existing traveling water screens as a retrofit device without substantial modification of the traveling water screen.

A preferred embodiment of a traveling water screen in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

- 4 -

Figure 1 is a perspective view of a traveling water screen unit installed in a sluice, and embodying various features of the invention.

Figure 2 is an enlarged side view of the traveling water screen unit shown in Figure 1.

Figure 3 is an enlarged view, partially in section, of the upper portion of the traveling water screen unit shown in Figure 2.

Figure 4 is an enlarged view taken along line 4-4 in Figure 2.

Figure 5 is a partial perspective view of a screen unit shown in Figure 4.

Figure 6 is an enlarged partial top view, partially in section, of the shield apparatus shown in Figure 3.

Figure 7 is a partial side view of the shield apparatus shown in Figure 6.

Figures 8 through 11 are partial side views of the shield apparatus taken along line X-X in Figure 6, and showing only the shield apparatus and screen units with the shield member in successive positions relative to a screen unit as the screen unit moves past the shield member. Figure 8 shows the shield member adjacent the upper end of the screen unit.

Figure 9 shows the shield member as the screen unit is cleaned by a fluid spray. Figure 10 shows the shield member in a retracted position. Figure 11 shows the shield member adjacent the upper end of the next successive screen unit.

- 5 -

Before this embodiment of the invention is described in detail, it is to be understood that the invention is not limited in its application to the details of the construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limited.

Figure 1 illustrates a water screening or filtering installation 10 which includes a concrete structure 12 and a traveling water screen unit 14 embodying the invention, as will be more fully described below.

The concrete structure 12 extends across a watercourse and includes a channel floor 16 and a pair of spaced apart, parallel channel walls 18 and 20 extending upwardly from the channel floor 16 to define an inlet water channel or sluice 22 which has water flowing therethrough in the direction shown by arrow F. Each of the channel walls 18 and 20 includes a vertical guide slot 24 in its inside face (see Fig. 4). A walkway 26 is supported on top of the channel walls 18 and 20, and includes spaced apart main and auxiliary debris channels 28 and 30 separated from each other by an opening 32 (see Fig. 2).

The traveling screen unit 14 is positioned in the sluice 22, and includes a frame 36 having a pair of vertically disposed support posts 38 and 40 supported on the channel floor

- 6 -

16 and extending upwardly through the opening 32. As shown in Figure 4, the support posts 38 and 40 are preferably Z-shaped and each includes a rear outwardly projecting flange 42 which fits into one of the guide slots 24, and a front inwardly projecting flange 44. A pair of angle iron guide rails 46 spaced downstream from each of the inwardly projecting flanges 44 are secured by means such as welding to the inward facing side of the support posts 38 and 40 to form guide channels 48.

As shown in Figure 2, the frame 36 also includes a pair of brackets 50 (only one is shown). Each of the brackets 50 extends downstream from the lower end of one of the support posts 38 and 40. A curved boot plate 52 immediately above the channel floor 16 interconnects the lower ends of the support posts 38 and 40.

The frame 36 also includes an upper drive housing 54 supported on the support posts 38 and 40 above the walkway 26. The drive housing 54 includes a front splash housing 56 which includes a pair of detachable side covers 57 and 58, and which extends over the main debris channel 28. The sides of the front splash housing 56 each include a centrally positioned generally horizontal slot 59 and 60 (See Fig. 6). The drive housing 54 also includes a rear splash housing 61 extending over the auxiliary debris channel 30. The front and rear splash housings 56 and 61 include respective trough members 62 and 63 for directing debris into the main and auxiliary debris channels 28 and 30, as will be further explained below.

The traveling water screen unit 14 also includes rotating drive means including a horizontally disposed head shaft 64 mounted in bearings (not shown) on a take-up mechanism 66 which is supported on the drive housing 54. As shown in

- 7 -

Figure 6, the head shaft 64 includes a pair of head sprockets 68 mounted on opposite ends of the head shaft 64, and a driven sprocket 70 mounted outside of the head sprocket 68 on one end of the head shaft 64. The head shaft 64 is driven by a chain 72 between the driven sprocket 70 and a drive motor and gear reducer (not shown).

As shown in Figure 2, the drive means also includes a horizontally disposed foot shaft 74 supported by the brackets 50, and two hexagonal foot sprockets or traction wheels 76 rotateably mounted on the foot shaft 74 inwardly of the brackets 50.

The traveling water screen unit 14 also includes a plurality of screen units 80. Each of the screen units 80 includes an upper lip beam 82, a lower lip pan or bucket 84, and opposite end plates 86 interconnecting the ends of the beam 82 and the bucket 84 to form a generally rectangular frame structure. When the screen unit 80 is in the upright position, the bucket 84 holds water and is adapted to receive aquatic life such as fish 98.

Each screen unit 80 also includes a screening panel 90 which slants outwardly from the bucket 84 to the beam 82, and which is fastened at its marginal edges to each of the beam 82 and the bucket 84, and to the end plates 86. The screening panels 90 are preferably made of a wire mesh through which water passes, and on which debris impinges. Each screen unit 80 also includes a bucket lip member 94 positioned forwardly of the screening panel 90 and extending upwardly from the outer edge of the bucket 84. The bucket lip member 94 is preferably made of a smooth textured mesh which discourages stapling of debris thereto, and which provides a smooth surface to reduce injury to the fish 98.

- 8 -

The traveling water screen unit 14 also includes a pair of parallel endless support chains 100 each trained over one of the head sprockets 68 and one of the traction wheels 76. As shown in Figure 5, each of these support chains 100 includes links 102 which are provided with intermediate guide rollers 104 and flanges 106.

The screen units 80 are arranged in series and connected between the support chains 100 by securing the flanges 106 to corresponding opposite plates 86. The endless screen member formed by the series of screen units 80 includes an upward run 108 wherein screen units 80 ascend, and a downward run 110 wherein screen units 80 descend. As screen units 80 travel upwardly in the upward run 108, they carry with them water and fish 98 in the upwardly opening buckets 84, and debris deposited on the screening panels 90 so that the water flowing through the sluice 22 is continually filtered. In the upward run 108, the support chains 100 are guided in the guide channels 48. The guide channels 48 function as a labyrinth seal for exclusion of fish and debris, and also support the chains 100 against the hydraulic force of the water flowing through the sluice 22.

The traveling water screen unit 14 also includes means for removing or cleaning debris from successive screen units 80, and especially from successive screening panels 90. While various cleaning means can be employed, in the illustrated construction the cleaning means includes a first high pressure spray apparatus 112 which includes a conduit fitted with a plurality of nozzles for directing jets of water or cleaning fluid toward the successive screen units 80. As shown in Figure 3, the first spray apparatus 112 is positioned within

- 9 -

the drive housing 54 on the downstream side of the upward run 108. As debris is flushed from the screening panels 90 by the spray apparatus 112 it is directed into the main debris channel 28 by the trough member 60 for disposal.

The cleaning means also includes a second high pressure spray apparatus 114 which also includes a conduit fitted with a plurality of nozzles for directing jets of water toward successive screening units 80 in the downward run 110. The second spray apparatus 114 facilitates even further cleaning of debris from the screen units 80. Debris removed by the second spray apparatus 114 is directed into the auxiliary debris channel 30 by the trough member 62.

The traveling water screen unit 14 also includes means for shielding fish 98 or other aquatic life from the debris removed from the screening units 80. While various shielding means can be employed, in the illustrated construction, the shielding means includes a shield apparatus 116 having a horizontally disposed shield member or plate 118 positioned within the front splash housing 56 and on the upstream side of the upward run 108. The shield member 118 includes a leading edge 120.

As shown in Figure 6, the shield apparatus 116 also includes means for supporting the shield member 118 for movement, the supporting means including a pair of slide bars 122 and 124. The slide bars 122 and 124 are mounted beneath the covers 57 and 58 on the front splash housing 56 by forward and rearward slide bearings 126 and 128. Each of the slide bars 122 and 124 includes a roller member 130 on the forward end thereof, a flange shoulder 132 positioned rearwardly of the roller member 130, and a compression spring 134 between the

- 10 -

flange shoulder 132 and the forward bearing 126. A crossmember 136 extends between the slide bars 122 and 124 and through the slots 59 and 60, and supports the shield member 118 thereon.

The shield apparatus 116 also includes means for positioning the shield member 118 above each successive bucket 84 as the screening panel 90 associated therewith is acted upon by the first spray apparatus 112. In the illustrated construction the positioning means includes a cam shaft 138 journaled at opposite ends on the side covers 57 and 58. The cam shaft 138 includes at least one and preferably a pair of cams 140. The cams 140 are identical and are positioned on opposite ends of the cam shaft 138 outside of the front splash housing 56 and beneath the side covers 57 and 58. The springs 134 bias each of the slide bars 122 and 124 toward one of the cams 140 so that the roller members 130 remain in contact with the cams 140. The cams 140 are configured to impart motion to the shield member 118 as the cam shaft 138 rotates, to thereby maintain the leading edge 120 in closing spaced relation to each successive screening panel 90 as it travels upwardly past the shield member 120. To accomplish this end, each cam 140 includes a curvilinear portion 142 for gradually extending the shield member 118 toward each successive screening panel 90, and a linear portion 144 for rapidly withdrawing the shield member 120 to avoid contact with the bucket lip member 94. Although the leading edge 120 is spaced closely to successive screening panels 90 to prevent debris from falling between the shield member 118 and each screening panel 90, it is not so closely spaced as to scrape debris from the screening panels.

- 11 -

The positioning means also includes a large diameter first sprocket 146 mounted on the head shaft 64, and a small diameter second sprocket 148 mounted on the cam shaft 138 outside of the side cover 58. A drive chain 150 couples the first and second sprockets 146 and 148. The first and second sprockets 146 and 148 are sized to rotate the cam shaft 134 at a rate causing the shield member 118 to follow the contour of the upstream face of successive screen units 80, as described above. The shield apparatus 116 is thus synchronized to position the shield member 118 over each successive bucket 84 with the leading edge 120 adjacent the associated screening panel 90 as the screening panel portion above the shield member 118 is cleaned by the first spray apparatus 112. The shield member 118 is withdrawn in time to avoid contact with the bucket lip member 94.

Operation of the shield apparatus 116 is illustrated in Figures 8 through 11, wherein the sequence begins with Figure 8 and ends with Figure 11. In Figure 8, the shield member 118 is positioned with its leading edge 120 adjacent the upper end of a screening panel 90. As the screen unit 80 moves upwardly past the shield member 118, the shield member 118 remains positioned above the bucket 84 and the first spray apparatus 112 acts on the portion of the screening panel 90 above the shield member 118 (See Fig. 9). As illustrated in Figure 10, as the shield member 118 approaches the bucket lip member 94 the roller member 130 encounters the linear portion 144 of the cam 140 to withdraw the shield member 118 from the screen unit 80. As shown in Figure 10, the roller member 130 then re-encounters the curvilinear portion 142 of the cam 140

- 12 -

and the shield member 118 is repositioned with its leading edge 120 adjacent the screening panel 90 of the next successive screen unit 80.

The traveling water screen unit 14 also includes means for returning fish 98 to the water at a remote location. While various means for returning can be employed, in the illustrated construction the returning means includes a fish trough 152 above the trough member 62 in the rear splash housing 61, and a low pressure spray apparatus for assisting the removal of fish 98 from successive buckets 84. The low pressure spray apparatus includes an outside fish spray conduit 156 disposed on the downstream side of the downward run 110, and an inside fish spray conduits 158 disposed on the upstream side of the downward run 110. Each of the fish spray conduits 156 and 158 is provided with nozzles for directing a low pressure jet of water toward the screen units 80 in the downward run 110. The water emitted from the nozzles is preferably in the range of 10-15 psi, a comfortable level for the fish. The water spray from the fish spray conduits 156 and 158 assists in transferring the fish 98 into the fish trough 152 and keeps the release path awash with water.

Various features of the invention are set forth in the following claims.

- 13 -

CLAIMS

1. A traveling water screen for filtering debris and aquatic life from water flowing through a sluice, said traveling water screen comprising

a frame,

an endless screen member supported on said frame for travel through the water, and adapted to carry debris and aquatic life,

means adjacent said endless screen member for removing debris deposited thereon, and

means for shielding aquatic life carried by said endless screen member from debris removed therefrom.

2. A traveling water screen as set forth in Claim 1, wherein said endless screen member has an upstream upward run including a series of screen units, each of said screen units comprising a bucket which opens upwardly to receive aquatic life, and an associated screening panel extending upwardly from said bucket, and wherein said means for removing debris acts successively on each of said screening panels, and said means for shielding includes a shield member, and means for successively positioning said shield member above each of said buckets as said screening panel associated therewith is acted upon by said means for removing debris.

- 14 -

3. A traveling water screen as set forth in Claim 1, wherein said endless screen member includes a series of screen units, each of said screen units comprising a bucket opening in the direction of travel of said endless screen member to receive aquatic life, and a screening panel associated with said bucket and extending therefrom in the direction of travel of said endless screen member, and wherein said means for removing debris acts successively on each of said screening panels, and said means for shielding includes a shield member positioned adjacent said endless screen member to successively prevent entry of debris into each of said buckets while said screening panel associated therewith is acted upon by said means for removing debris.

4. A traveling water screen as set forth in Claim 3, wherein said series of screen units includes an upstream upward run, and wherein said shield member is disposed on the upstream side of said upward run, and includes a leading edge, and said means for shielding includes means for maintaining said leading edge successively adjacent each of said screening panels.

5. A traveling water screen as set forth in Claim 4, wherein said shield member is moveable in a direction transverse to the direction of travel of said screen units in said upward run, and wherein said means for maintaining includes a cam wherein movement of said shield member is actuated by said cam.

- 15 -

6. A traveling water screen as set forth in Claim 5, wherein said cam is engageable with said shield member, and is configured to maintain said leading edge in closely spaced relation to each of said successive screening panels.

7. A traveling water screen as set forth in Claim 6, wherein said means for maintaining includes a cam shaft rotateably supported on said frame, said cam being mounted on said cam shaft.

8. A traveling water screen as set forth in Claim 7, said traveling water screen comprising rotating drive means over which said succession of screen units operates, said drive means including a horizontally disposed driven head shaft, and wherein said means for maintaining includes a first sprocket mounted on said head shaft, a second sprocket on said cam shaft, and a cam shaft drive member coupling said first sprocket and said second sprocket.

9. A traveling water screen as set forth in Claim 8, wherein said means for maintaining includes means for biasing said shield member toward said cam to maintain contact between said shield member and said cam, said means for biasing including a spring, and wherein said shield member includes a roller member contacting said cam.

- 16 -

10. A traveling water screen as set forth in Claim 4, wherein said shield member is positioned above the water level, and wherein said series of screen units includes a downstream downward run, and said traveling water screen includes a trough member downstream of said downward run for returning aquatic life received in said buckets to the water.

11. A traveling water screen as set forth in Claim 1, wherein said endless screen member includes an outer face, and wherein said means for shielding includes a shield member adjacent said outer face, and means for moving said shield member to generally follow the contour of said outer face as said outer face travels past said shield member.

12. A traveling water screen for filtering debris and aquatic life from water, said traveling water screen comprising an endless screen member having an upward run, said endless screen member including a revolving series of screen units, each of said screen units including a bucket which opens upwardly when in said upward run to receive aquatic life, and a screening panel associated with said bucket and extending from said bucket in the direction of travel of said revolving series, means disposed on the downstream side of said upward run for removing debris deposited on said endless screen member, said means for removing acting successively on each of said screening panels, and means for preventing debris removed from said endless screen member from entering said buckets.

- 17 -

13. A traveling water screen as set forth in Claim 12, wherein said means for preventing includes a shield member disposed on the upstream side of said upward run.

14. A traveling water screen as set forth in Claim 13, wherein said means for preventing includes means for successively positioning said shield member above each of said buckets when said screening panel associated therewith is acted upon by said means for removing debris.

15. A traveling water screen as set forth in Claim 14, wherein said shield member includes a leading edge, and said means for successively positioning maintains said leading edge in closely spaced relation to each successive screening panel.

16. A traveling water screen as set forth in Claim 15, wherein said shield member is moveable in a direction transverse to the direction of travel of said screen units in said upward run, and wherein said means for successively positioning includes a cam wherein movement of said shield member is actuated by said cam.

17. A traveling water screen as set forth in Claim 16, wherein said cam is configured to maintain said leading edge in closely spaced relation to said successive screening panels.

- 18 -

18. A traveling water screen as set forth in Claim 17, wherein said means for removing debris includes means on the downstream side of said upward run portion for directing a jet of fluid toward said upward run portion and above said shield member.

19. A shield apparatus for use with a traveling water screen including an endless screen member having an upward run, the endless screen member including a series of screen units each including a bucket which opens in the direction of travel of the endless screen member to receive aquatic life, and a screening panel associated with the bucket and extending therefrom in the direction of travel of the endless screen member, and an apparatus for removing debris from successive screening panels, said shield apparatus comprising,

a shield member on the upstream side of the upward run, and

means for successively positioning said shield member above each bucket as the screening panel associated therewith is acted upon by the apparatus for removing debris.

20. A shield apparatus as set forth in Claim 19, wherein said shield member includes a leading edge, and said means for positioning maintains said leading edge in closely spaced relation to each of the successive screening panels.

- 19 -

21. A shield apparatus as set forth in Claim 20, wherein said shield member is moveable in a direction transverse to the direction of travel of the screen units in the upward run portion, and wherein said means for positioning includes a cam engageable with said shield member to impart movement thereto.

22. A shield apparatus as set forth in Claim 21, wherein said cam is configured to maintain said leading edge in closely spaced relation to each of the successive screening panels.

23. A shield apparatus as set forth in Claim 22, wherein said shield member includes a roller member engageable with said cam, and wherein said means for positioning includes a cam shaft, said cam being mounted on said cam shaft, and a spring for biasing said shield member toward said cam to maintain contact between said cam and said roller member.

24. A shield apparatus as set forth in Claim 23, wherein the cleaning apparatus includes means on the downstream side of the upstream run portion for directing a jet of fluid toward the endless screen member and above said shield member.

-20-

Patents Act 1977

Examiner's report to the Comptroller under
Section 17 (The Search Report)

Relevant Technical fields

(i) UK Cl (Edition ^K) } B1D (DMPA, DMFX, DMLB, DMLC,
 DPLD)
 5 B01D
(ii) Int Cl (Edition)

Application number

9122581.3

Search Examiner

R T HAINES

Databases (see over)

(i) UK Patent Office
(ii) ONLINE: WPI

Date of Search

29 JANUARY 1992

Documents considered relevant following a search in respect of claims 1 TO 24

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	None	

SF2(p)

sw - c:\wp51\doc99\fil000805



2-1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1992 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mills Point, Cwmbach, Cwmbach, Wales, NP1 7HZ. Printed by Multiplex Techniques Ltd, St Mary Cray, Kent.